

## PATENT ABSTRACTS OF JAPAN

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(71)Applicant : MATSUSHITA ELECTRIC IND CO LTD

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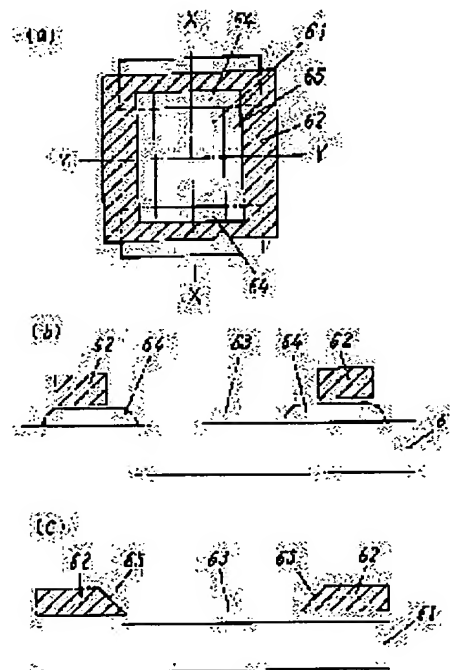
(72)Inventor : SENDA KENJI  
YAMADA HIROYUKI  
NAKATANI MITSUNARI

## (54) METAL MASK, FORMATION OF RESISTOR BY USING THIS METAL MASK AND PRODUCTION OF RESISTOR USING THIS METAL MASK

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To prevent the incident limitation of sputter particles in the corner parts of aperture flanks and to form a thin-film resistor which is thick in the film thickness at ends and has excellent electrical characteristics by forming a taper increased in a hole diameter toward a sputter vapor deposition source in the aperture of the metal mask.

**SOLUTION:** A pair of electrodes 64, 64 are formed on a heat resistant and insulative substrate 61 mainly composed of  $Al_2O_3$  and a pair of the opposite flanks of the metal masks 62 made of iron, etc., having the square aperture 63 are placed thereon. The metal masks are in close contact with the electrodes so as to be overlapped and one aligned. The sputter particles from the sputter vapor deposition source are supplied to the aperture 63 of the metal mask 62 to deposit the thin-film resistor of Ni-Cr, etc., across the electrodes 64, 64 on the substrate 61. At this time, the other pair of the opposite flanks of the metal mask 62 are provided with the taper 65 increases in the hole diameter toward the sputter vapor deposition source of the aperture 63. The angle of inclination of the taper 65 is preferably set at about 15 to 80°, more particularly about 30 to 65° with the surface of the metal mask 62.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The metal mask which has in an aperture the taper which enlarged the aperture according to the direction of the source of spatter vacuum evaporationo.

[Claim 2] An aperture is a metal mask according to claim 1 which has the taper with which only the side of a pair enlarged the aperture.

[Claim 3] The formation approach of the resistor which forms a thin film resistor in a substrate with a spatter method of construction at an aperture using the metal mask which has the taper which enlarged the aperture according to the direction of the source of spatter vacuum evaporationo.

[Claim 4] An aperture is the formation approach of a resistor according to claim 3 that only the side of a pair forms a thin film resistor at a substrate using the metal mask which has the taper with which the aperture was enlarged.

[Claim 5] The formation approach of the resistor according to claim 4 which uses a metal mask for the substrate in which the electrode was formed, carries out alignment in which said electrode was formed so that the side which enlarged the aperture to said electrode of a pair, and the adjacent side may be connected with said electrode, and forms a thin film resistor.

[Claim 6] An electrode is the formation approach of a resistor according to claim 5 which consists of the thin film or thick film of Au system, Cu system, nickel system, and Ag system.

[Claim 7] The manufacture approach of a resistor including the process which makes alignment in which said electrode was formed the substrate in which the electrode was formed so that the side which enlarged the aperture to said electrode of a pair, and the adjacent side may be connected with said electrode using the metal mask which has in an aperture the taper which enlarged the aperture according to the direction of the source of spatter vacuum evaporationo, and forms a thin film resistor.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a metal mask, the formation approach of the resistor which used this metal mask, and the manufacture approach of the resistor using this metal mask.

[0002]

[Description of the Prior Art] In order to raise packaging density with the miniaturization of electronic equipment in recent years also to the electronic parts used for the circuit board, the demand to a miniaturization is increasing increasingly. The demand to the small and highly precise resistor of resistance tolerance has been increasing also to a resistor for adjust[ no ]-izing of an electronic circuitry.

[0003] Hereafter, the formation approach of a resistor using the conventional metal mask and the conventional metal mask and the manufacture approach of the resistor using the conventional metal mask are explained, referring to a drawing.

[0004] Drawing 7 is the sectional view of the conventional metal mask. The metal mask which was able to do 1 with a metal or the magnetic substance, and 2 are apertures. here -- a metal mask -- the plate of a metal or the magnetic substance -- FOTORISO -- an aperture 2 is produced using law. At this time, the include angle to the mask front face of aperture 2 side face is almost right-angled.

[0005] A drawing is used and explained below about the formation approach of the resistor which used the conventional metal mask.

[0006] Drawing 8 (a) is the top view showing \*\*\*\* of the metal mask at the time of the resistor formation which used the conventional metal mask. (b) is this X-X sectional view, and (c) is this Y-Y sectional view.

Drawing 9 is a Y-Y sectional view in drawing 8 at the time of the resistor formation by the spatter method of construction (a), and the arrow head in drawing shows the direction of incidence of sputtered particles.

[0007] The aperture 13 of the rectangle of the metal mask 12 sticks so that it may superimpose to the electrode 14 of the pair produced to the substrate 11, and it carries out alignment. At this time, the side face of the aperture 13 of a metal mask is almost right-angled to a metal mask front face. In this condition, a thin film resistor 15 is formed on the substrate 11 of the mask aperture 13 with a spatter method of construction, using sources of spatter vacuum evaporatono, such as nickel-Cr, as a resistor.

[0008] The manufacture approach of a resistor of having used the conventional metal mask for below is explained referring to a drawing.

[0009] Drawing 10 is process drawing showing the manufacture approach of the resistor using the conventional metal mask. First, as shown in drawing 10 (a), the electrode paste which becomes the flank of the top face of the substrate 31 which contains an alumina 96% and becomes, and an inferior surface of tongue from the metal organic substance etc. is screen-stenciled and dried. Then, by heating with a firing furnace, only the organic component of electrode paste is flown, only a metal component can be burned on a substrate 31, and the top-face electrode layer 32 and an inferior-surface-of-tongue electrode layer (not shown) are formed.

[0010] Next, as shown in drawing 10 (b), the conventional metal mask in drawing 8 is stuck on the top face of the substrate 31 in which the top-face electrode layer 32 was formed, it puts into a sputtering system, and pattern formation of the resistor layer 33 is carried out with a spatter method of construction. At this time, the side face of the aperture of a metal mask is almost right-angled.

[0011] Next, in order to make the resistor layer 33 into a stable resistor, it heat-treats. Next, as shown in drawing 10 (c), in order to correct the resistance of the resistor layer 33 to a predetermined value, by laser

trimming etc., the trimming slot 34 is given and resistance correction is made.

[0012] Next, as shown in drawing 10 (d), in order to protect the resistor layer 33 (not shown in this Fig.) which gave the trimming slot 34 and made resistance correction, a resin paste is screen-stenciled so that the resistor layer 33 may be covered, and it heat-hardens, and a protective layer 35 is formed.

[0013] Next, as shown in drawing 10 (e), the side-face electrode layer 36 which consists of thin films, such as nickel-Cr, with a sputter method of construction is formed so that the top-face electrode layer 32 and/or the resistor layer 33, and an inferior-surface-of-tongue electrode layer (not shown) may be connected to the side face of a substrate 31.

[0014] Finally, if needed, by electroplating, nickel plating layer (not shown) and the solder plating layer (not shown) were formed in the top-face electrode layer 32 and inferior-surface-of-tongue electrode layer (not shown) which have been exposed, and the side-face electrode layer 36, and the resistor was manufactured in them.

[0015]

[Problem(s) to be Solved by the Invention] However, when the thin film resistor of a resistor forms with a sputter method of construction using the above-mentioned conventional metal mask, as shown in drawing 9 , the direction of incidence of sputtered particles is various (the arrow head in drawing shows), the incidence of the sputtered particles to aperture 13 edge of the metal mask 12 is restricted by the side face of the metal mask 12, and the thickness of the edge of the thin film resistor 15 on a substrate becomes thin. For this reason, when a part of resistor was removed and resistance was corrected by laser trimming etc., the load focused near the edge of a resistor and the technical problem that electrical characteristics, such as the pulse characteristics of a resistor, deteriorated occurred.

[0016] This invention solves the above-mentioned technical problem, and offers the metal mask for forming the thin film resistor excellent in electrical characteristics.

[0017]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the metal mask of this invention forms the taper which enlarged the aperture according to the direction of the source of sputter vacuum evaporation.

[0018]

[Embodiment of the Invention] Invention of this invention according to claim 1 is the metal mask characterized by having in an aperture the taper which enlarged the aperture according to the direction of the source of sputter vacuum evaporation.

[0019] Moreover, the aperture according to claim 1 of invention according to claim 2 is a metal mask for resistor formation with which only the side of a pair has the taper which enlarged the aperture.

[0020] Moreover, invention according to claim 3 is the formation approach of the resistor which forms a thin film resistor in an aperture with a sputter method of construction using the metal mask which has the taper which enlarged the aperture according to the direction of the source of sputter vacuum evaporation.

[0021] Moreover, the aperture of invention according to claim 4 is the formation approach of a resistor that only the side of a pair forms a thin film resistor using the metal mask which has the taper which enlarged the aperture.

[0022] Moreover, invention according to claim 5 uses a metal mask for the substrate in which the electrode according to claim 4 was formed, it carries out alignment in which the electrode was formed so that the side which enlarged the aperture to said electrode of a pair, and the adjacent side may be connected with said electrode, and it forms a thin film resistor.

[0023] Moreover, invention according to claim 6 is the formation approach of a resistor that an electrode according to claim 5 consists of the thin film or thick film of Au system, Cu system, nickel system, and Ag system.

[0024] Moreover, invention according to claim 7 makes alignment in which said electrode was formed the substrate in which the electrode was formed so that the side which enlarged the aperture to said electrode of a pair, and the adjacent side may be connected with said electrode using the metal mask which has in an aperture the taper which enlarged the aperture according to the direction of the source of sputter vacuum evaporation, and it includes the process which forms a thin film resistor.

[0025] (Gestalt 1 of operation) The metal mask by the gestalt 1 of operation of this invention, the formation

approach of a resistor using this metal mask, and the manufacture approach of the resistor using this metal mask are explained hereafter, referring to a drawing.

[0026] Drawing 1 is the sectional view of the metal mask in the gestalt 1 of operation of this invention. In drawing, 51 is the taper of a metal or the magnetic substance, a desirable iron metal mask, and the side face of this aperture in which 53 gave [ as opposed to / in 52 / the mask front face ] the include angle of 30 - 65 degrees preferably 15 to 80 degrees as opposed to the aperture.

[0027] Below, the formation approach of a resistor using the metal mask in the gestalt 1 of operation of this invention is explained, referring to a drawing.

[0028] This X-X sectional view and drawing 2 (c) of the top view and drawing 2 (b) which show \*\*\*\* of the metal mask at the time of the resistor formation using a metal mask [ in / in drawing 2 (a) / the gestalt 1 of this invention operation ] are these Y-Y sectional views. Drawing 3 is a Y-Y sectional view in drawing 2 (a).

[0029] First, the aperture 63 of the rectangle of the metal mask 62 sticks so that it may superimpose to the electrode 64 of the pair formed on the substrate 61, and it carries out alignment. At this time, the side face of a pair in which the aperture of the rectangle of the metal mask 62 faces each other has the taper 65 which gave the include angle of 30 - 65 degrees preferably 15 degrees to 80 degrees to the front face of a metal mask, as shown in drawing 1 . Alignment is performed so that this side and the adjacent side may be connected to the electrode 64 of a pair.

[0030] Then, a substrate 61 and the metal mask 62 are put into a sputtering system, and a resistor 66 is formed for resistor ingredients, such as nickel-Cr, on the substrate 61 of the mask aperture 63 with a spatter method of construction. At this time, as shown in drawing 3 , with the taper 65 formed in the side face of the pair of the aperture of a metal mask, the incidence of the sputtered particles of an aperture side face becomes is hard to be restricted, the thickness of a resistor edge becomes thick compared with the case where a resistor is formed using the conventional metal mask, and its electrical characteristics of a resistor improve.

[0031] Below, the manufacture approach of the resistor using the metal mask in the gestalt 1 of this invention operation is explained, referring to a drawing.

[0032] Drawing 4 is process drawing showing the manufacture approach of the resistor in the gestalt 1 of operation of this invention. First, as shown in drawing 4 (a), the electrode paste which becomes the flank of the top face of the substrate 81 which comes to contain an alumina 96% excellent in thermal resistance and insulation, and an inferior surface of tongue from the metal organic substance which uses Au as a principal component is screen-stenciled and dried. Next, only an organic component is flown, since only a metal component can be burned on a substrate 81, it calcinates by the profile for 45 minutes at the temperature of about 850 degrees C with a belt type continuous furnace, and the top-face electrode layer 82 and an inferior-surface-of-tongue electrode layer (not shown) are formed.

[0033] Next, as shown in drawing 4 (b), the metal mask of this invention shown in drawing 1 is stuck on the top face of the substrate 81 in which the top-face electrode layer 82 was formed, and the resistor layers 83, such as nickel-Cr, are formed with a spatter method of construction. Since a taper is in the side face of an aperture with the metal mask of this invention at this time, the incidence of sputtered particles is not intercepted, the thickness of the edge of the resistor layer 83 becomes thicker than the time of the resistor formation using the conventional metal mask, and its electrical characteristics of a resistor improve.

[0034] Next, in order to make the resistor layer 83 into a stable resistor, it heat-treats in an about 300-400-degree C ambient atmosphere.

[0035] Next, as shown in drawing 4 (c), in order to correct the resistance of the resistor layer 83 to a predetermined value, by laser trimming etc., the trimming slot 84 is given and resistance correction is made.

[0036] Next, as shown in drawing 4 (d), in order to protect the resistor layer 83 (not shown in this Fig.) which gave the trimming slot 84 and made resistance correction, the resin paste of an epoxy system is screen-stenciled, it heat-hardens on about 200 degrees C and the conditions for 30 minutes, and a protective layer 85 is formed.

[0037] Next, as shown in drawing 4 (e), the side-face electrode layer 86 which consists of thin films, such as nickel-Cr, with a spatter method of construction is formed so that the top-face electrode layer 82 and/or the resistor layer 83, and an inferior-surface-of-tongue electrode layer (not shown) may be connected to the side face of a substrate 81.

[0038] Finally, for reservation of the dependability at the time of prevention and soldering of the electrode foods crack at the time of soldering of the top-face electrode layer 82 and inferior-surface-of-tongue electrode

layer (not shown) which have been exposed if needed, and the side-face electrode layer 86, by electroplating, nickel plating layer (not shown) and a solder plating layer (not shown) are formed, and a resistor is manufactured.

[0039] The resistor in the gestalt 1 of operation of this invention constituted and manufactured as mentioned above becomes thick compared with that in which the thickness of the edge of a resistor layer was formed using the conventional metal mask. By this, manufacture of the thin film resistor which was excellent in electrical characteristics is attained.

[0040] Hereafter, it compared by the experiment approach shown below about the resistor manufactured using the conventional metal mask, and the resistor manufactured using the metal mask of the gestalt 1 of operation of this invention.

[0041] As the experiment approach, in order to evaluate pulse characteristics, the result of having measured the rate of a change in resistance after repeating the cycle which is not impressed [ impression and ] during 25 seconds 10000 times for 1 second for a 3 times as many load as rated voltage is shown in drawing 11 .

[0042] Compared with the conventional resistor, the rate of a change in resistance became small, and the resistor in the gestalt 1 of operation of this invention was able to aim at improvement in electrical characteristics so that clearly from drawing 11 .

[0043] (Gestalt 2 of operation) The metal mask by the gestalt 2 of operation of this invention, the formation approach of a resistor using this metal mask, and the manufacture approach of the resistor using this metal mask are explained hereafter, referring to a drawing.

[0044] The metal mask which has the cross section shown in drawing 5 in formation of a resistor and which formed the taper 93 of a stairway mold in aperture 92 side face is used. At this time, the include angle 94 of the edge of metal mask 91 top face of aperture 92 side face, the flat surface surrounded at the end of the inferior surface of tongue, and a metal mask front face is 30 - 65 degrees preferably 15 degrees to 80 degrees.

[0045] The formation approach of a resistor using this metal mask and the manufacture approach of a resistor are the same as the gestalt 1 of operation, and since the same is said of effectiveness, they omit explanation.

[0046] (Gestalt 3 of operation) The metal mask by the gestalt 3 of operation of this invention, the formation approach of a resistor using this metal mask, and the manufacture approach of the resistor using this metal mask are explained hereafter, referring to a drawing.

[0047] The metal mask which formed the taper 103 of the field which has curvature in aperture 102 side face which has the cross section shown in drawing 6 in formation of a resistor is used. At this time, the include angle 104 of the edge of metal mask 101 top face of aperture 102 side face, the flat surface surrounded at the end of the inferior surface of tongue, and a metal mask front face is 30 - 65 degrees preferably 15 degrees to 80 degrees.

[0048] Similarly to the gestalt 1 of operation, since the formation approach of a resistor using this metal mask and the manufacture approach of a resistor are the same also about effectiveness, they omit explanation.

[0049]

[Effect of the Invention] As mentioned above, if a thin film resistor is formed with a spatter method of construction using the metal mask by this invention, with the taper formed in the side face of the pair of an aperture, the incidence of the sputtered particles of an aperture side face becomes is hard to be restricted, the thickness of a resistor edge will become thick compared with the case where a resistor is formed using the conventional metal mask, and its electrical characteristics of a resistor will improve.

[0050] Therefore, if a thin film resistor is formed with a spatter method of construction using the metal mask by this invention, the resistor excellent in electrical characteristics can be offered.

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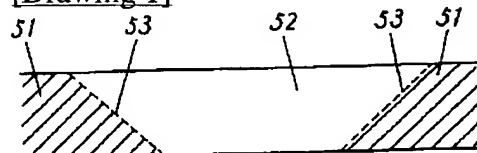
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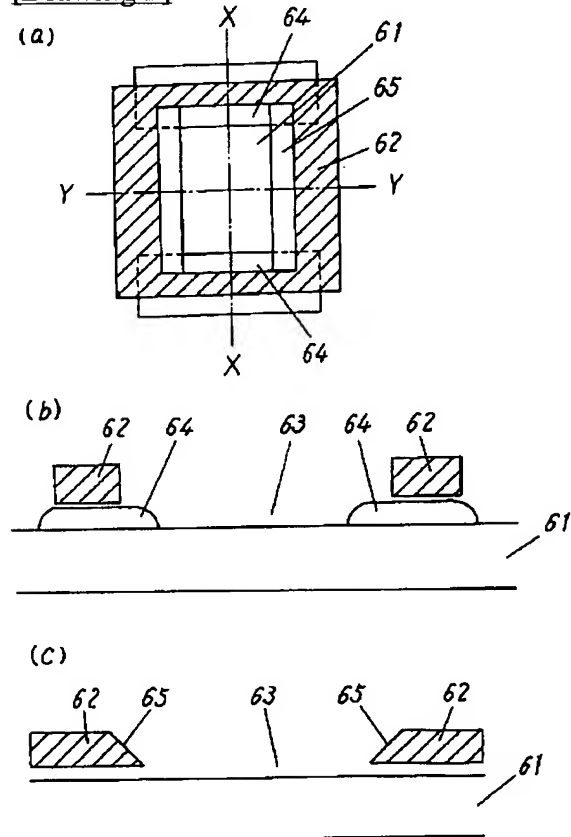
DRAWINGS

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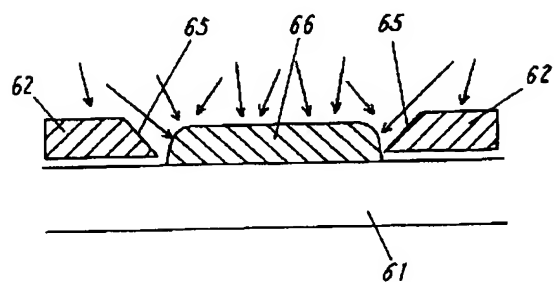
[Drawing 1]



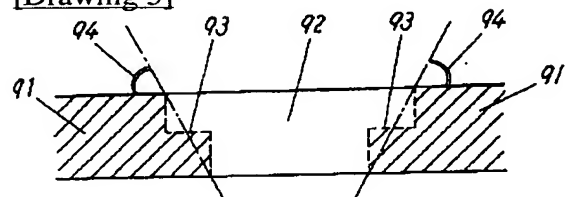
[Drawing 2]



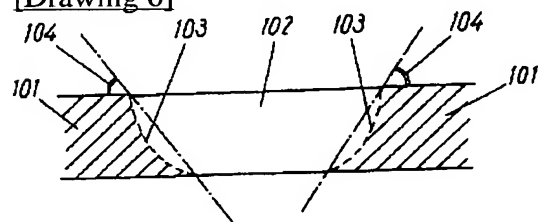
[Drawing 3]



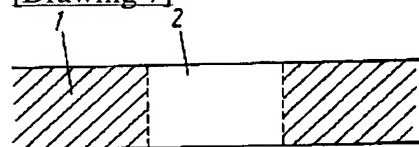
[Drawing 5]



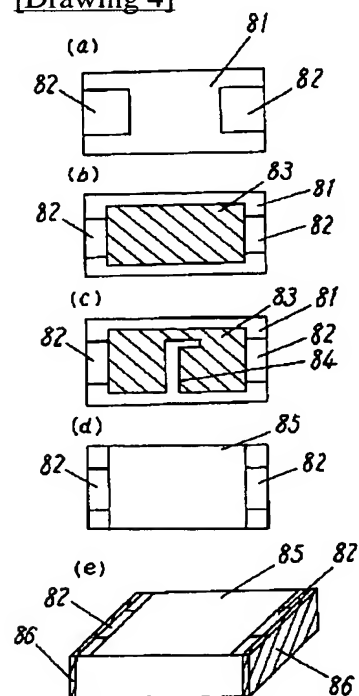
[Drawing 6]



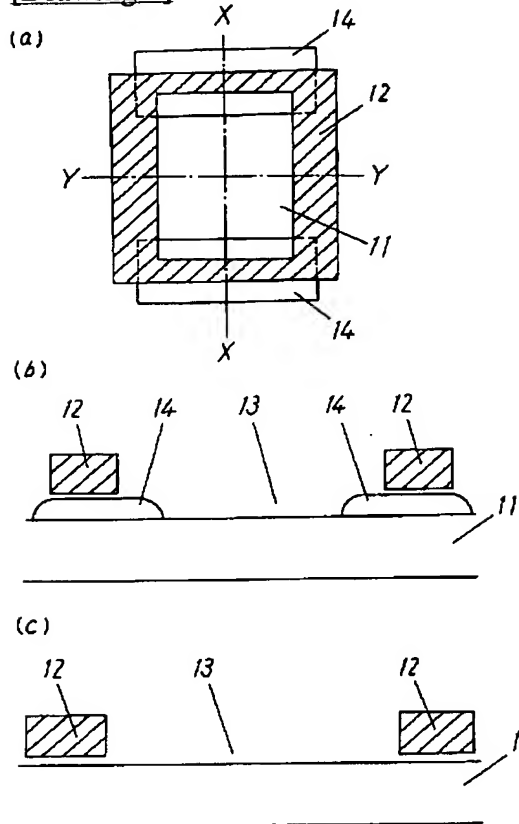
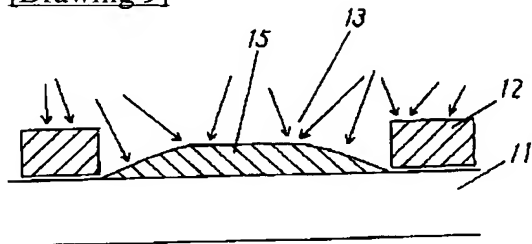
[Drawing 7]

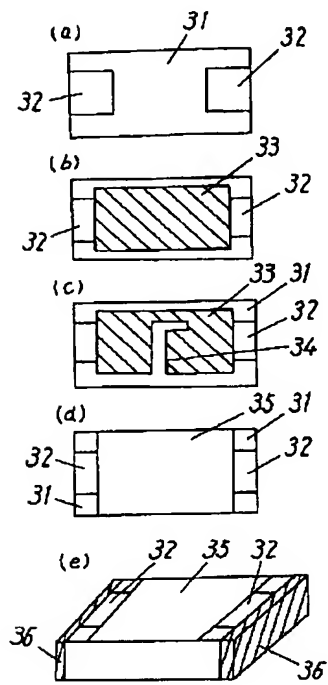


[Drawing 4]

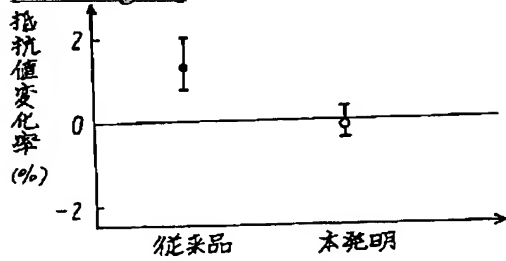




[Drawing 8][Drawing 9][Drawing 10]



[Drawing 11]



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